Appendix B
# Species Accounts of ASIP-Covered Species with the Potential to Occur in the Study Area

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# B.1 Federally Listed Species

## B.1.1 San Joaquin Kit Fox

The San Joaquin kit fox (*Vulpes macrotis mutica*) is listed as threatened under CESA and as endangered under the ESA (32 Federal Register [FR] 4001). No critical habitat has been designated for this species.

### B.1.1.1 Distribution

The historical range of the San Joaquin kit fox is unknown; however, it is believed to have extended from Contra Costa and San Joaquin Counties in the north to Kern County in the south. By the 1930s, the species' range had been reduced to the southern and western portions of the Central Valley (Grinnell et al. 1937). Surveys conducted between 1969 and 1975 extended the known range of the kit fox back into portions of its historical range in the northern San Joaquin Valley, including Contra Costa, Alameda, and San Joaquin Counties (Orloff et al. 1986). Kit foxes were found in Monterey, Santa Clara, and Santa Barbara Counties, which were previously thought to be outside the species' historic range (Orloff et al. 1986).

By 1975, the kit fox population size was estimated to be 7,000 individuals (U.S. Fish and Wildlife Service 1983; California Department of Fish and Game 1989). Most of the species' range still supports kit foxes (California Department of Fish and Game 1989), although populations are declining (California Department of Fish and Game 1988). Kit fox populations in the northern portion of the species' range are small and isolated (U.S. Fish and Wildlife Service 1983).

## B.1.1.2 Life History and Habitat Requirements

The San Joaquin kit fox occurs in open, arid habitats, including alkali desert scrub, grassland, and valley foothill hardwood habitats (U.S. Fish and Wildlife Service 1983). The alkali desert scrub association, which historically was one of the dominant cover types in the San Joaquin Valley before the expansion of irrigation agriculture, was probably the species' prime habitat (Grinnell et al. 1937).

The San Joaquin kit fox is carnivorous and primarily nocturnal. Major prey includes kangaroo rats, black-tailed hares, desert cottontails, deer mice, and California ground squirrels. Although kangaroo rats are a dominant prey item in the San Joaquin Valley (U.S. Fish and Wildlife Service 1983), California ground squirrels are the most important prey item in some other portions of the kit fox's range (Balestreri 1981; Hall 1983; O'Farrell et al. 1987; Clifton 1989). The kit fox apparently does not require drinking water (Egoscue 1956; Morrell 1972).

The home range size of the San Joaquin kit fox ranges from 640 to 1,280 acres, with substantial overlap among individuals (Morrell 1972; Zoellick et al. 1987). The kit fox usually inhabits areas with loose-textured soils suitable for den excavation (U.S. Fish and Wildlife Service 1983). Where soils make digging difficult, the fox frequently uses and modifies burrows built by other animals (Orloff et al. 1986). Artificial structures, such as culverts, abandoned pipelines, and well casings, may also be used as den sites (U.S. Fish and Wildlife Service 1983).

## B.1.1.3 Endangerment

The San Joaquin kit fox population has declined primarily as a result of habitat loss in the San Joaquin Valley (U.S. Fish and Wildlife Service 1983). Other factors in the decline of the kit fox include road kill, illegal shooting and trapping, and secondary poisoning and prey reduction from rodent control programs.

## B.1.1.4 Occurrence in the Study Area

It is unlikely the San Joaquin kit fox occurs in the study area because of the lack of large expanses of suitable habitat and the lack of migration corridors from suitable habitats in the region. The range of this species does not include most of the Sacramento–San Joaquin Delta (Delta); however, Byron Tract and the Old River flow barrier are in or near the species' range.

There is one U.S. Fish and Wildlife Service (USFWS) sighting of a San Joaquin kit fox on the levee near the Old River barrier site. No signs of recent kit fox activity were observed during preconstruction surveys performed at the Old River barrier site in 1998 (Rooks pers. comm.). Den surveys were performed on several occasions between 1994 and 2001 for maintenance work performed at the proposed intake facility area. No signs of recent kit fox activity were observed during these surveys. Preconstruction surveys were conducted in 1998 for the Old River–Tracy DMC barrier because there was one USFWS record of kit fox near that barrier site. Kit fox surveys have not been performed in other portions of the study area.

## B.1.2 Riparian Brush Rabbit

The riparian brush rabbit (*Sylvilagus bachmani riparius*) is listed as endangered under CESA and ESA (65 FR 36:8881–8890). No critical habitat has been designated for this species.

### B.1.2.1 Distribution

Historically, the riparian brush rabbit inhabited riparian communities along the lower portions of the San Joaquin and Stanislaus Rivers in the northern San Joaquin Valley. The riparian brush rabbit currently inhabits riparian communities along the lower portions of the San Joaquin and Stanislaus Rivers in the northern San Joaquin Valley. The current range of the riparian brush rabbit is restricted to populations at Caswell Memorial State Park in San Joaquin County, along the Stanislaus River, along an overflow of the San Joaquin River (FR 65 36:8881–8890), and on an in-channel island on Paradise Cut (Starr pers. comm.; Olah pers. comm.).

Although suitable habitat is present in the study area, the only known population of riparian brush rabbit in the study area occurs on an in-channel island along Paradise Cut. This population is located approximately 2–3 miles upstream of the confluence of the San Joaquin River. The riparian brush rabbit population on Paradise Cut is approximately 3 miles east of the Old River channel dredging site and 2 miles south of the head of Old River barrier. Although this species occurs in the vicinity of project features, neither riparian brush nor suitable habitat for this species occur at the head of Old River barrier site or the Old River channel dredging and disposal area.

Surveys conducted in all potential habitat along the Merced, San Joaquin, Stanislaus, and Tuolumne Rivers during 1985 and 1986 failed to find any additional populations of riparian brush rabbits (Williams 1988). The most recent estimates indicate the population comprises 170–608 individuals over 198 acres (Williams 1993). A population low of 10 or fewer individuals was estimated following severe winter flooding in 1985 and 1986 (Williams 1988). The flooding during winter 1996–1997 also severely affected the population. The riparian brush rabbit population is declining (California Department of Fish and Game 1992a).

### B.1.2.2 Life History and Habitat Requirements

Habitat for the riparian brush rabbit consists of riparian forests with a dense understory shrub layer. Common plants in the habitat include willow thickets (*Salix* spp.), California wild rose, California blackberry (*Rubus* spp.), California wild grape, coyote brush, and grasses (Williams 1988; Basey 1990). This subspecies avoids large openings in shrub cover and is unable to disperse beyond the dense brush of the riparian forest it inhabits. As a result, brush rabbits have small home ranges that usually conform to the size of available brushy habitat (Basey 1990).

### B.1.2.3 Endangerment

Riparian brush rabbit populations have declined primarily as a result of habitat loss in the San Joaquin Valley. Other potential threats to this species include habitat conversion to agriculture, wildfire, disease, predation, flooding, clearing of riparian vegetation, and the use of rodenticides. The species is at risk from the lack of elevated mounds with protective cover to serve as flood refuges within remaining riparian habitat.

### B.1.2.4 Occurrence in the Study Area

Although suitable habitat is present in the study area, the only known population of riparian brush rabbit occurs at Caswell Memorial State Park, San Joaquin County, along the Stanislaus River and along an overflow of the San Joaquin River. These locations are outside the study area; therefore, riparian brush rabbits are not expected to occur in the study area. Surveys were not performed in the study area for this species.

The riparian brush rabbit requires dense riparian vegetation cover and does not move through more sparsely vegetated or herbaceous habitats; therefore, it is unlikely that riparian brush rabbits would migrate across the sparsely vegetated region between their known range and the study area. Additionally, the relatively sparse riparian vegetation in the study area would provide relatively low-value habitat for this species.

## B.1.3 Giant Garter Snake

The giant garter snake (*Thamnophis gigas*) is listed as threatened under the ESA (58 FR 54053, October 20, 1993) and CESA. No critical habitat has been designated for this species.

## B.1.3.1 Distribution

Historically, the giant garter snake was found throughout the Central Valley, from Butte County south to Kern County. Wetland reclamation and agricultural development extirpated the giant garter snake from the southern one-third of its range during the 1940s and 1950s (Hansen and Brode 1980). Giant garter snake populations are presently limited to ponds, sloughs, marshes, and rice fields of Sacramento, Sutter, Butte, Colusa, and Glenn Counties. Remnant populations exist along the western border of the Yolo Bypass in Yolo County and along the eastern fringes of the Delta from the Laguna Creek–Elk Grove region of Sacramento County south to Stockton, San Joaquin County (Hansen 1986; 58 FR 54053, October 20, 1993). Within the San Joaquin Valley, the giant garter snake is still presumed to occur in Fresno County (Burrel/Lanare area and in the Mendota area), Merced County (North and South Grasslands), and San Joaquin County (White Slough/Caldoni Marsh) (U.S. Fish and Wildlife Service 1999).

## B.1.3.2 Life History and Habitat Requirements

The giant garter snake is endemic to emergent wetlands in the Central Valley. The species' habitat includes marshes, sloughs, ponds, small lakes, and low-gradient waterways, such as small streams, irrigation and drainage canals, and rice fields (58 FR 54053, October 20, 1993). The giant garter snake is active from approximately May to October and hibernates during the remainder of the year. The giant garter snake requires adequate water with herbaceous, emergent vegetation for protective cover and foraging habitat. Primary food items include fish, tadpoles, and frogs (Hansen and Brode 1980). Open areas and grassy banks are needed for basking. Small mammal burrows and other small crevices at higher elevations provide winter hibernation sites and refuge from floodwaters (58 FR 54053, October 20, 1993).

All three habitat components (i.e., cover and foraging habitat, basking areas, and protected hibernation sites) are needed. Riparian woodlands and large rivers typically do not support giant garter snakes because these habitats lack emergent vegetation, basking areas, and prey populations (Hansen and Brode 1980). Emergent vegetative cover provides snakes with necessary cover to avoid predation by introduced fish (58 FR 54053, October 20, 1993).

## B.1.3.3 Endangerment

Habitat loss as a result of agricultural development and flood control activities has been the primary factor in the decline of giant garter snake populations. Additional causes of mortality include vehicular traffic, agricultural practices, and maintenance of water channels. Small remaining populations are also susceptible to predation by fish, mammals, and birds.

### B.1.3.4 Occurrence in the Study Area

There are no recent occurrences of giant garter snake in the study area; however, suitable low-to-moderate-quality habitat exists in portions of the study area (Rooks pers. comm.). Within the San Joaquin Valley, the giant garter snake is still presumed to occur in specific areas within Fresno, Merced, and San Joaquin Counties. The San Joaquin County population occurs within White Slough and Caldoni Marsh (U.S. Fish and Wildlife Service 1999). White Slough and Caldoni Marsh are approximately 20 miles north of the study area.

DWR performed surveys in the study area to determine the suitability of onsite habitats for the giant garter snake (Rooks pers. comm.). The surveys, which were performed in September 2002, included the Byron Tract–LDS Property, Clifton Court Forebay (CCF), Grant Line Canal barrier site, Old River at Delta-Mendota Canal (DMC) barrier, and the Middle River barrier site, to assess the habitat's value to the giant garter snake. The Head of Old River barrier site was not evaluated because permission to enter was not obtained. DWR used a species-specific evaluation method to describe the quality of the potential giant garter snake habitat found on the land side of each site (Hansen 2002). Waterside habitat evaluations that were conducted by Hansen (Hansen 2002).

The Byron Tract area provides low-to-moderate-quality habitat in irrigation ditches. Approximately 395 feet (120 meters) of waterway provide moderate-quality habitat, while the remainder provides either no habitat value or low-quality habitat. The area around the CCF provides two ponds, one of a low-to-moderate-quality habitat value and the other of a moderate-to-high quality habitat value. The outboard side of the CCF levees (i.e., those adjacent to West Canal and Italian Slough) is almost entirely covered in riprap and provides no habitat value to giant garter snakes.

All potential habitat within approximately 330 feet (100 meters) of the proposed Grant Line Canal barrier was surveyed. This area consists of toe drains, an irrigation ditch, waterside levees, and an in-channel island. Most of the area would provide moderate-quality habitat to giant garter snakes; however, the waterside of levees offers no value. The in-channel island would provide moderate-quality habitat to giant garter snakes. The outer edges of the in-channel island provide good emergent vegetation and upland hibernation sites, but overstory vegetation and predatory fish are also present.

All potential habitat within approximately 330 feet (100 meters) of the proposed limit-of-construction line at the Old River at DMC barrier was surveyed. Two permanent ditches provide moderate-quality giant garter snake habitat. The short toe ditch provides no habitat value. The waterside of the levee on the south side of the barrier provides low-quality habitat, and the north side provides no habitat to giant garter snakes.

All potential habitat within approximately 330 feet (100 meters) of the proposed Middle River barrier was surveyed. This area consists of toe drains and the waterside of the levees. The toe drains provide primarily moderate-quality habitat to giant garter snakes. The surveys determined that the exterior levees provide no habitat value to the giant garter snake.

# B.1.4 Fall/Late Fall–Run Chinook Salmon

The fall/late fall–run Chinook salmon (*Oncorhynchus tshawytscha*) is listed as a candidate species under the ESA (64 FR 179:50393–50415, September 16, 1999).

## B.1.4.1 Distribution

In the Central Valley, fall/late fall–run Chinook historically spawned in all major streams draining the Sierra Nevada, but fish passage has since been blocked by dams (Moyle 2002). Currently, fall/late fall–run Chinook salmon compose about 80% of the total Chinook salmon produced in the Sacramento and San Joaquin drainages (Kjelson et al. 1982). Fall/late fall–run Chinook salmon spawn in the Sacramento and San Joaquin Rivers and most of their tributaries.

## B.1.4.2 Life History and Habitat Requirements

After 2–5 years in the ocean, adult Chinook salmon leave the ocean and migrate upstream to the Sacramento River and its numerous tributaries to spawn. Chinook salmon take advantage of the diversity and variability of river systems through life history adaptations (Moyle 2002). The names of the Chinook salmon runs (i.e., fall, late fall, spring, and winter) reflect the variability in life history timing of the adult fish. Spawning occurs in the cool reaches of Central Valley rivers that are just downstream of the terminal dams. Adult fall/late fall–run Chinook salmon spawn soon after entering fresh water. Chinook salmon deposit their eggs in redds (i.e., gravel nests) located on riffles, runs, and pool tails. Eggs generally hatch in 6–9 weeks, and yolk-sac larvae remain in the gravel for several more weeks. After emergence, juvenile Chinook salmon may rear along the channel edge or begin their movement downstream. Juvenile Chinook salmon may remain in fresh water for 3–14 months.

Adult fall/late fall–run Chinook salmon migrate into the Sacramento River and its tributaries from July to December. Fall/late fall–run Chinook salmon spawn between early October and late December, and incubation takes place during October–March. The peak of spawning is in October and November as water cools. The life history of the fall/late fall–run Chinook salmon is similar to that of the winter-run and spring-run Chinook salmon.

### B.1.4.3 Endangerment

Many factors have contributed to the population decline of Central Valley fall/late fall–run Chinook salmon: loss and degradation of spawning and rearing habitat, alteration of stream flows, overharvest, entrainment into water diversions, blockage of migration routes, exposure to toxins, and, possibly, loss of genetic viability from interbreeding with hatchery stocks. The human-caused factor that perhaps has had the greatest effect on the abundance of Chinook salmon runs is loss of habitat, primarily in the rivers upstream of the Delta. Major dams block upstream access to most Chinook salmon habitat in Central Valley rivers and streams. Smaller dams (e.g., the Red Bluff Diversion Dam [RBDD]) in the lower watersheds also delay migration of adults or increase predation on downstream-migrating juvenile salmon (Bureau of Reclamation 1983). Harvest rates on wild stocks are also a potential cause of the population declines.

### B.1.4.4 Occurrence in the Study Area

Fall/late fall–run Chinook salmon migrate as adults and juveniles through the Delta. Those fish migrating to the San Joaquin system will consistently pass the study area in both life stages; juveniles may rear in the study area before migrating as well. After emergence, juvenile fall/late fall–run Chinook salmon begin their movement or downstream migration. Rearing habitat is limited within the study area because conditions become unfavorable during the summer when water temperature and dissolved oxygen (DO) do not meet the habitat requirements for fall/late fall–run Chinook salmon. Other factors, such as reduced amounts of riparian vegetation and channel complexity, limit the amount of available rearing habitat.

The Sacramento River fall/late fall–run Chinook salmon move in a similar manner to the winter-run and spring-run Chinook salmon. Chinook salmon up to 350 mm are captured at the fish facilities typically from December to June but sometimes also in October. Spawning and incubation do not occur in the project area.

## B.1.5 Spring-Run Chinook Salmon

The spring-run Chinook salmon (*O. tshawytscha*) is listed as threatened under the California Endangered Species Act (CESA) and the federal Endangered Species Act (ESA) (64 Federal Register [FR] 179:50393–50415, September 16, 1999). Critical habitat was designated for this species but was later withdrawn (U.S. District Court for the District of Columbia, April 30, 2002).

## B.1.5.1 Distribution

The spring-run Chinook salmon was historically the second most abundant run of Central Valley Chinook salmon (Fisher 1994). It occupied the headwaters of all major river systems in the Central Valley where there were no natural barriers. Spring-run Chinook salmon, like steelhead, migrated farther into headwater streams where cool, well-oxygenated water was available year round.

Current surveys indicate that remnant, nonsustaining spring-run Chinook salmon populations may be found in Cottonwood, Battle, Antelope, and Big Chico Creeks (California Department of Water Resources 1997). More sizeable, consistent runs of naturally produced fish are found only in Mill and Deer Creeks. The Feather River Fish Hatchery sustains the spring-run population on the Feather River, but the genetic integrity of that run is questionable (California Department of Water Resources 1997). Feather River water has been diverted to Butte Creek for many years; therefore, the genetic integrity of the Butte Creek population is also uncertain. Spring-run Chinook salmon may occur in the Yuba River; however, the size of the run and the level of possible hybridization with fall/late fall–run Chinook are unknown (California Department of Fish and Game 1998). No runs of spring-run Chinook salmon occur in the San Joaquin River or any of its tributaries.

## B.1.5.2 Life History and Habitat Requirements

Historical records indicate that adult spring-run Chinook salmon enter the mainstem Sacramento River in February–March, continue to their spawning streams, and then hold in deep, cold pools until they spawn. Spring-run Chinook salmon are sexually immature during their spawning migration. Spawning occurs in gravel beds in late August–October, and emergence takes place in March–April. Spring-run Chinook salmon appear to emigrate at two different life stages: as fry or as yearlings. Fry emigrate between February and June, and yearlings emigrate between October and March, peaking in November (Cramer and Demko 1997).

During spawning, the female digs a redd (i.e., gravel nest) in which she deposits her eggs, which are then fertilized by the male. The optimal water temperature for egg incubation is 44.1–54.0ºF (6.7–12.2ºC) (Rich 1997). Newly emerged fry remain in shallow, lower velocity edgewaters, particularly where debris accumulates and makes the fry less visible to predators (California Department of Fish and Game 1998). Juvenile spring-run Chinook salmon rear in their natal streams, the mainstem of the Sacramento River, and in the Delta. Juveniles that remain in their natal streams tend to emigrate as yearlings. Juveniles that emigrate downstream to the ocean as yearlings move with the onset of the stormy season, beginning in October of the year following spawning and continuing through March (California Department of Fish and Game 1998).

### B.1.5.3 Endangerment

Spring-run Chinook salmon populations began declining in the 20th century as a result of natural and human-related factors. These factors include loss of habitat in river reaches blocked by dams, degradation of habitat conditions (e.g., water temperature), entrainment in water diversions, and overharvesting. Loss of habitat, primarily in the rivers upstream of the Delta, is the human-caused factor that has had the greatest effect on the abundance of spring-run Chinook salmon runs. Major dams have blocked upstream access to most Chinook salmon habitat in Central Valley rivers and streams, and smaller dams contribute to migration delay. On most Central Valley streams, spring-run Chinook salmon are restricted to habitats with marginal water temperature conditions and limited deep holding areas. Water diversions and reservoir operations affect streamflow, which influences the quantity, quality, and distribution of Chinook salmon spawning and rearing habitat. Water diversions also reduce survival of emigrating juvenile salmonids through direct entrainment losses in unscreened or inadequately screened diversions. Predation on emigrating salmonids at diversion dams, such as the RBDD, may also be an important survival factor (Bureau of Reclamation 1983).

### B.1.5.4 Occurrence in the Study Area

Spring-run Chinook salmon migrate as adults and juveniles through the Delta. Those fish migrating to the San Joaquin system will consistently pass through the study area in both life stages; juveniles may rear in the study area before migrating as well. After emergence, juvenile spring-run Chinook salmon begin their movement or downstream migration. Rearing habitat is limited within the study area because conditions become unfavorable during the summer when water temperature and dissolved oxygen levels do not meet the habitat requirements of spring-run Chinook salmon. Other factors, such as reduced amounts of riparian vegetation and channel complexity, limit the amount of available rearing habitat.

Although juvenile spring-run Chinook salmon migrate from the Sacramento River, they could be pulled toward the study area when exports are taking place. Chinook salmon up to almost 4 inches (350 millimeters [mm]) are captured at the fish facilities, typically from January to June but sometimes also in August and October–December. Spawning and incubation do not occur in the project area.

## B.1.6 Winter-Run Chinook Salmon

The winter-run Chinook salmon (*O. tshawytscha*) is designated as an endangered species under the ESA (59 FR 2:440-450, January 4, 1994) and as endangered under CESA. The following areas are designated as critical habitat for winter-run Chinook salmon (58 FR 114:3312-33219, June 16, 1993): the portion of the Sacramento River from Keswick Dam to Chipps Island, all waters westward from Chipps Island to the Carquinez Strait Bridge, all waters of San Pablo Bay, and all waters of San Francisco Bay north of the San Francisco–Oakland Bay Bridge. Critical habitat includes the river water, river bottom, and adjacent riparian zone (i.e., those adjacent terrestrial areas that directly affect a freshwater aquatic ecosystem).

### B.1.6.1 Distribution

Winter-run Chinook historically migrated all the way to the headwaters of the Sacramento River, but barriers now keep winter-run Chinook salmon to the river below Shasta Dam.

### B.1.6.2 Life History and Habitat Requirements

Adult winter-run Chinook salmon leave the ocean and migrate through the Delta into the Sacramento River from November to July. Salmon migrate upstream past the RBDD on the Sacramento River from mid-December to July, and most of the spawning population has passed the RBDD by late June.

Winter-run Chinook salmon spawn from mid-April to August, and incubation continues through October. The primary spawning grounds in the Sacramento River are above the RBDD. Some fish may spawn below RBDD, but deleterious temperatures below the RBDD kill the eggs most summers (Fisher pers. comm.).

Juvenile winter-run Chinook salmon rear and emigrate in the Sacramento River from July to March (Hallock and Fisher 1985; Smith pers. comm.). Juveniles descending the Sacramento River above the RBDD from August to October, and possibly November, are mostly presmolts (smolts are juveniles that are physiologically ready to enter seawater) and probably rear in the Sacramento River below the RBDD. Juveniles have been observed in the Delta during October through December, especially during high Sacramento River discharge caused by fall and early winter storms.

Juvenile Chinook salmon move out of upstream spawning areas into downstream habitats in response to many factors, including inherited behavior, habitat availability, flow, competition for space and food, and water temperature. The number of juveniles that move and the timing of movement are highly variable. Storm events and the resulting high flows appear to trigger movement of substantial numbers of juvenile Chinook salmon to downstream habitats. In general, juvenile abundance in the Delta increases as flow increases (U.S. Fish and Wildlife Service 1993).

Adult winter-run Chinook salmon spend 1–3 years in the ocean. About 67% of the adult escapement that leaves the ocean to spawn in the Sacramento River consists of 3-year-old salmon, 25% consists of 2-year-old salmon, and 8% consists of 4-year-old salmon (Hallock and Fisher 1985).

### B.1.6.3 Endangerment

Major factors believed to have contributed to the decline of winter-run Chinook salmon are blockage of adult passage to suitable spawning and rearing areas above the RBDD and deleterious water temperatures during egg incubation and early rearing. Other factors that may impede recovery to former levels of abundance and continue to adversely affect winter-run salmon include:

- increased high summer water temperatures below Keswick Dam;
- blockage of adult migration at the RBDD;
- predation on juveniles at the RBDD;
- loss of juveniles to entrainment into unscreened or poorly screened diversions, including:
  - Anderson-Cottonwood Irrigation District, Glenn-Colusa Irrigation District, and the RBDD diversions,
  - south-Delta Central Valley Project and State Water Project pumping plants; and
- bank modification; and
- riparian habitat loss.

Drought and poor ocean habitat conditions have also contributed to low run sizes in recent years. Overharvest in sport and commercial fisheries may have contributed to depressed populations.

### B.1.6.4 Occurrence in the Study Area

Winter-run salmon smolts may migrate through the Delta and San Francisco Bay to the ocean from December to as late as May (Stevens pers. comm.). The Sacramento River is the main migration route through the Delta. Although water drawn through the Delta Cross Channel (DCC) and Georgiana Slough transports an unknown number of migrants into the Delta south and east of the Sacramento River.

Chinook salmon up to 350 mm are captured at the fish facilities, typically from December to June but sometimes also in October. Spawning and incubation do not occur in the project area.

## B.1.7 Central Valley Steelhead

The Central Valley steelhead (*O. mykiss*) is listed as threatened under the ESA (63 FR 53:13347-13371, March 19, 1998) and as a species of special concern by the California Department of Fish and Game (DFG). Critical habitat was designated for this species but was later withdrawn (U.S. District Court for the District of Columbia, April 30, 2002).

### B.1.7.1 Distribution

The Central Valley steelhead historically inhabited large and small streams throughout the Sacramento–San Joaquin watershed. It is now restricted to the upper Sacramento River downstream of Keswick Reservoir; the lower reaches of large tributaries downstream of impassable dams; small, perennial tributaries of the Sacramento River mainstem and large tributaries; and the Delta and San Francisco Bay system.

### B.1.7.2 Life History and Habitat Requirements

Steelhead, a sea-run rainbow trout, exhibit one of the most complex life histories of any salmonid (i.e., trout or salmon) species. Steelhead are capable of having an anadromous life history or a freshwater residency. Resident individuals are typically called rainbow trout, and anadromous individuals are called steelhead.

Because of mixed genetic stock from past hatchery releases and changes in flow timing and magnitude associated with water resources development projects, steelhead in the Sacramento River migrate upstream from July to May. Spawning in the Sacramento River basin typically occurs from late December to April, with most spawning occurring in January–March. Unlike Chinook salmon, which die after spawning, steelhead can survive spawning and live to spawn more than once. Steelhead require relatively clean, cool (less than 57°F) water in which to spawn successfully. The eggs hatch anywhere from 19 days to 80 days after spawning, depending on water temperature (warmer temperatures result in faster hatching times), and the young remain in the gravel for several weeks before emerging as fry.

Steelhead juveniles spend a minimum of 1 year, but typically 2 years, in fresh water before emigrating to the ocean as smolts. Smolt emigration generally occurs from November to May, although, based on salvage data at the state and federal pumping plants in the Delta, the peak months for emigration in most years appear to be March and April. After spending 2–3 years in the ocean, steelhead return to their natal stream to spawn when they are 4 or 5 years old.

### B.1.7.3 Endangerment

Factors related to the decline of Central Valley steelhead include loss of habitat in river reaches blocked by dams, degradation of habitat conditions (e.g., water temperature), and entrainment in water diversions. Loss of habitat has the greatest effect on steelhead abundance. Major dams are the primary barriers to steelhead access to Central Valley rivers and streams. Dams at low elevations on all major tributaries block access to an estimated 95% of historical spawning habitat in the Central Valley (Reynolds et al. 1993; National Marine Fisheries Service 1996). Below dams, remnant steelhead populations are affected by varying flow conditions and high summer and fall water temperatures. Unscreened agricultural, municipal, and industrial diversions in the Delta and rivers cause entrainment losses of emigrating juvenile steelhead.

More than 90% of the adult steelhead in the Central Valley are produced in hatcheries (Reynolds et al. 1990). Hatchery-produced fish may substantially affect the genetic integrity of wild populations. Adult and juvenile steelhead are harvested by sport anglers in the Central Valley watershed. There is no commercial or sport fishery for steelhead in the ocean and, for unknown reasons, steelhead are rarely taken by commercial or sport salmon trollers (Skinner 1962).

### B.1.7.4 Occurrence in the Study Area

Central Valley steelhead use the project area as a migration corridor during upstream (i.e., adult) and downstream (i.e., juvenile) migration. After emergence, juvenile steelhead begin their movement or downstream migration. Rearing habitat is limited in the study area because conditions become unfavorable during the summer when water temperature and DO do not meet the habitat requirements for steelhead. Other factors, such as reduced amounts of riparian vegetation and channel complexity, limit the amount of available rearing habitat. Spawning and incubation do not occur in the project area.

Central Valley steelhead up to 350 mm are captured at the fish facilities, typically from February to April but sometimes also in December, January, and May.

## B.1.8 Delta Smelt

The delta smelt (*Hypomesus transpacificus*) is listed as threatened under the ESA (58 FR 42:12854-12864, March 5, 1993), and as threatened under the CESA. Critical habitat was designated for delta smelt on December 19, 1994 (59 FR 242:65265-65279).

### B.1.8.1 Distribution

The delta smelt is endemic to the Delta. It typically occurs downstream of Isleton on the Sacramento River and below Mossdale on the San Joaquin River. It is seasonally found in Suisun Bay and the larger sloughs of Suisun Marsh. During spawning season, delta smelt move into channels and sloughs of the western Delta (including Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore Sloughs). When Delta outflows are high, delta smelt may be washed into San Pablo Bay but do not establish permanent populations there. In drought years, most delta smelt are found in the northwestern part of the Delta near the Sacramento River. During high outflow years, delta smelt can occur anywhere from the Sacramento River near Decker Island to Suisun Bay. (Moyle 2002.)

### B.1.8.2 Life History and Habitat Requirements

Delta smelt are typically found in waters where the salinity is between 2 and 7 parts per thousand (ppt). They will move to waters with salinities ranging between 0 and 18.4 ppt and can tolerate salinities up to 19 ppt. Because delta smelt are not strong swimmers, they typically occupy open, shallow waters (less than 10 feet [3 meters]). Delta smelt rear mostly in or just upstream of the region where fresh water and brackish water mix. DFG surveys collected delta smelt at a moderate level in both the open water and beach surveys. Delta smelt move toward the shallow edgewaters and slow-moving sloughs to spawn. This zone may be hydraulically conducive to their ability to maintain position.

Delta smelt begin a migration upstream, which may take several months, toward areas of the upper Delta during September and October. Spawning occurs between February and July, with the peak occurring between April and mid-May, in shallow edgewaters in the upper Delta and Sacramento River upstream of Rio Vista. Eggs are broadcast over the bottom, where they attach to the substrate and vegetation. Hatching takes approximately 9–13 days later, and feeding occurs 4–5 days later. Delta smelt larvae contain a large oil globule that makes them semibuoyant, which allows them to stay off the bottom and feed on rotifers and other zooplankton. As their fins develop, they move up in the water column. At this point, most delta smelt are washed downstream toward the mixing zone, where they are strong enough swimmers to move up and down in the water column, depending on where the food source is located.

Critical habitat for delta smelt is designated as all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in the existing contiguous waters within Suisun Bay and the Delta (59 FR 852; January 6, 1994). The primary constituent elements for the critical habitat are adult migration, spawning habitat, larval and juvenile transport, and rearing habitat and are described below.

- Adult migration—the Sacramento and San Joaquin River channels and tributaries, including Cache and Montezuma Sloughs and their tributaries. Unrestricted access must be provided to suitable spawning habitat in a period that may extend from December to July. Adequate flow and suitable water quality must be maintained and channels should be protected from physical disturbance and flow disruption.
- Spawning habitat—fresh or slightly brackish backwater sloughs and edgewaters of the Delta, Suisun Bay, and Montezuma Slough and its tributaries. Spawning habitat must provide suitable water quality and substrates for egg attachment. Spawning may start as early as December and extend until July.

- Larval and juvenile transport—channels of the Delta, Suisun Bay, and Montezuma Slough and its tributaries must be protected from physical disturbance and flow disruption (e.g., water diversions and in-channel barriers or tidal gates). Depending on the timing of peak spawning, channel flow must be adequate to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay and to prevent interception of larvae and juveniles by diversions.
- Rearing habitat—an area extending eastward from Carquinez Strait, including Suisun Bay, Grizzly Bay, Honker Bay, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River, including Big Break. Suitable water quality must be available and X2 must be maintained according to historical salinity conditions. Rearing habitat protection may be required from the beginning of February through the summer.

### B.1.8.3 Endangerment

Factors that contribute to low abundance relative to historical conditions include change in flow patterns, entrainment in diversions, contaminants, and species interactions, particularly competition and predation associated with establishment of nonnative species (Stevens et al. 1990; Herbold et al. 1992). Although effects of contaminants have not been specifically described for delta smelt, pesticides have been found in the Sacramento River in recent years at concentrations potentially harmful to fish larvae (Herbold et al. 1992). Recent bioassays by the Central Valley Regional Water Quality Control Board indicate that water in the Sacramento River is periodically toxic to larvae of the fathead minnow, a standard U.S. Environmental Protection Agency test organism (Stevens et al. 1990).

Food availability may be an important factor affecting survival of delta smelt larvae. Abundance of rotifers and phytoplankton has declined in recent years (Obrebski et al. 1992). Rotifers are small and may be important to the diet of larval delta smelt (California Department of Water Resource and Bureau of Reclamation 1993) and other fish larvae (Hunter 1981).

### B.1.8.4 Occurrence in the Study Area

Delta smelt have the potential to occur in any area of the Delta where suitable habitat exists. Adults and juveniles are captured at the fish facilities, typically between February and June.

# B.1.9 Green Sturgeon

The green sturgeon (*Acipenser medirostris*) is listed as a candidate species under the ESA (68 FR 19:4433-4441, January 29, 2003) and as a state species of special concern by the DFG. No critical habitat has been designated.

## B.1.9.1 Distribution

The green sturgeon is found in the lower reaches of large rivers from British Columbia south to the Sacramento River. The southernmost spawning population is in the Sacramento River. Spawning populations exist historically in the Eel and Klamath-Trinity River systems. The Klamath and Trinity Rivers still maintain a spawning population, but the Eel River does not. In the Central Valley, some spawning may occur in the lower Feather River and in the mainstem Sacramento River. Juvenile fish have been collected in the Sacramento River, near Hamilton City, and in the Delta and San Francisco Bay. Adults and juveniles have been observed near the RBDD in late winter and early spring. Individuals tagged by the DFG in the Delta have been recaptured off Santa Cruz, California, in Winchester Bay on the southern Oregon coast, at the mouth of the Columbia River, and in Gray's Harbor, Washington (Moyle 2002).

## B.1.9.2 Life History and Habitat Requirements

Not much is known about the life history of the green sturgeon because of its low abundance, low sport-fishing value, and limited spawning distribution (Moyle 2002). Green sturgeon are mostly marine fish, migrating into rivers to spawn. Early life stages may spend up to 2 years in fresh water (Moyle 2002). Green sturgeon also make extensive ocean migrations; consequently, most recoveries of individuals tagged in San Pablo Bay have come from the ocean and from rivers and estuaries in Oregon and Washington. Juveniles inhabit the estuary until they are approximately 4–6 years old, when they migrate to the ocean (Kohlhorst et al. 1991).

Migration of green sturgeon occurs between late February and late July in the Klamath River. Peak spawning periods occur from mid-April to mid-June. In the Sacramento River, sturgeon are seen in the river at about the same time, when temperatures are 8–14°C. Their spawning substrate ranges from sand to bedrock in deep (i.e., greater than 10 feet [3 meters]), fast water (Moyle 2002).

The diet of adult green sturgeon seems to mostly include bottom invertebrates and small fish (Ganssle 1966). Juveniles in the Delta feed on opossum shrimp and amphipods (Radtke 1966). Little information is available about green sturgeon age and growth; they seldom exceed 4 feet in length from the Delta (Skinner 1962; Moyle 2002).

### B.1.9.3 Endangerment

A number of presumed spawning populations in California (i.e., Eel River, South Fork Trinity River, San Joaquin River) have apparently been lost in the last 25–30 years. The only known spawning now takes place in the Sacramento, Klamath, and Rogue (Oregon) Rivers, all of which are affected by water projects and intensive use of the watersheds.

In addition, at least 6,000–11,000 green sturgeon are harvested per year. Although there is no direct evidence of decline, the statistics are incomplete. It is possible the sturgeon fishery is harvesting a stock of large, old fish that cannot renew itself at present harvest rates. (Moyle 2002.)

### B.1.9.4 Occurrence in the Study Area

Little is known about the movements and habits of green sturgeon. It is assumed that they will migrate throughout the Delta and rivers during any time of the year; therefore, they could be present at the study area.

## B.1.10 Longfin Smelt

The longfin smelt (*Spirinchus thaleichthys*) is listed as a species of special concern by the DFG and is federally designated as a species of concern. No critical habitat has been designated.

### B.1.10.1 Distribution

Historically, longfin smelt populations were found in the Klamath, Eel, and San Francisco estuaries, and in Humboldt Bay. From current sampling, populations reside at the mouth of the Klamath River and the Russian River estuary. In the Central Valley, longfin smelt are rarely found upstream of Rio Vista or Medford Island in the Delta. Adults concentrate in Suisun, San Pablo, and North San Francisco Bays (Moyle 2002).

### B.1.10.2 Life History and Habitat Requirements

Longfin smelt are anadromous, euryhaline, and nektonic. Adults and juveniles are found in estuaries and can tolerate salinities from 0 ppt to pure seawater. After the early juvenile stage, they prefer salinities in the 15–30 ppt range (Moyle 2002).

Longfin smelt are found in San Pablo Bay in April–June and disperse in late summer. In the fall and winter, yearlings move upstream into fresh water to spawn. Spawning occurs below Medford Island in the San Joaquin River and below Rio Vista on the Sacramento River. Spawning may happen as early as November, and larval surveys indicate spawning may extend into June (Moyle 2002).

Embryos hatch in 40 days at 7°C and are buoyant. The larvae move into the upper part of the water column and are carried into the estuary. High outflows transport the larvae into Suisun and San Pablo Bays. In low outflow years, larvae move into the western Delta and Suisun Bay. Higher outflows are positively associated with juvenile survival and adult abundance. Rearing habitat is better in Suisun and San Pablo Bays because juveniles require brackish water in the 2–18 ppt range. If the larvae stay in the Delta, they become entrained and exposed to more adverse conditions. (Moyle 2002.)

### B.1.10.3 Endangerment

Potential contributors to the decline of longfin smelt include:

- low flows;
- entrainment losses to water diversions, particularly the Central Valley Project, State Water Project, and Pacific Gas and Electric Company plants;
- climatic variation (resulting in decreased Delta outflow);
- agricultural, municipal and industrial runoff;
- predation; and
- introduced species, particularly invertebrates that may alter foodweb dynamics.

### B.1.10.4 Occurrence in the Study Area

Juvenile and adult longfin smelt are infrequently captured at the fish facilities, typically in the spring. Longfin smelt typically occupy more saline habitats, such as Suisun Bay and farther west. Although spawning occurs in fresh water, most of the spawning activities occur downstream of Rio Vista on the Sacramento River side and at Medford Island on the San Joaquin River. Longfin smelt may sporadically be found in the study area.

## B.1.11 Splittail

The Sacramento splittail (*Pogonichthys macrolepidotus*) is listed as threatened under the ESA (64 FR 25:5963-5981, February 8, 1999) and as a species of special concern by the DFG. No critical habitat has been identified for this species.

### B.1.11.1 Distribution

The Sacramento splittail is largely confined to the Delta, Suisun Bay, Suisun Marsh, and Napa Marsh but are found up to Keswick (Moyle et al. 1995; Natural Heritage Institute 1992, Baxter pers. comm.). Historically, splittail ranged much farther upstream in the Sacramento and San Joaquin Rivers and their tributaries. In recent years, splittail appear to have expanded their range because of improved environmental conditions, increased abundance, and increased efforts to detect their presence at the periphery of their known range (Baxter 1999).

Meng and Moyle (1995) analyzed survey data collected from 1967 to 1993 and concluded that splittail abundance had declined 62% during this period. They also concluded that spawning runs that formerly ascended tributaries of the Sacramento and San Joaquin Rivers had largely disappeared. Fall midwater trawl surveys indicate that juvenile splittail abundance has been highly variable from year to year, with peaks and declines coinciding with wet and dry periods, respectively. Following low abundance during the 1987–1992 drought, splittail abundance indices rebounded to record or near-record levels in the high-flow years of 1995 and 1998 (Baxter 1999).

### B.1.11.2 Life History and Habitat Requirements

Splittail deposit adhesive eggs over flooded terrestrial or aquatic vegetation when water temperatures are between 9 and 20°C (Wang 1986; Moyle 2002). Splittail spawn in late April and May in Suisun Marsh and between early March and May in the upper Delta and lower reaches of the Sacramento and San Joaquin Rivers (Moyle et al. 1995). Surveys conducted by the DFG and DWR in 1995 indicate that the Yolo and Sutter Bypasses provide important spawning habitat (Baxter pers. comm.).

Spawning has been observed to occur as early as January and to continue through July (Wang 1986). Incidental catches of large splittail in fyke traps set by the DFG to catch migrating striped bass in the lower Sacramento River during spring indicate that splittail migrate from lower river reaches to upstream spawning habitats.

Larval splittail are commonly found in the shallow, vegetated areas where spawning occurs. Larvae eventually move into deeper, open water habitats as they grow and become juveniles. During late winter and spring, young-of-year splittail (i.e., less than 1 year old) are found in sloughs, rivers, and Delta channels near spawning habitat. Juvenile splittail gradually move from shallow, nearshore habitats to the deeper, open water habitats of Suisun and San Pablo Bays (Wang 1986). In areas upstream of the Delta, juvenile splittail can be expected to be present in the flood basins when these areas are flooded during the winter and spring (i.e., Sutter and Yolo Bypasses and the Sacramento River) (Jones & Stokes Associates 1993).

### B.1.11.3 Endangerment

The human-caused factor that has had the greatest effect on the abundance of splittail is loss and degradation of floodplain and marsh habitat (California Department of Fish and Game 1992b). Land reclamation, flood control practices, and agricultural development have eliminated and drastically altered much of the ephemeral and perennial shallow-water habitats in the lowland areas available to spawning adults, larvae, and juveniles. An estimated 96% of historical wetland habitats are either unavailable to splittail or have been eliminated (50 Code of Federal Regulations [CFR] 17). Splittail abundance is positively associated with high Delta outflows during primary spawning months (i.e., March–May) (California Department of Fish and Game 1992b; Sommer et al. 1997). High Delta outflows during late winter and spring correlate with increased total surface area of shallow-water habitats containing submerged vegetation (used by spawning adults), both in and upstream of the Delta. During low-flow years, such as the 1986–1992 drought, spawning success may be greatly reduced, contributing to reduced adult abundance.

### B.1.11.4 Occurrence in the Study Area

Splittail use the project area as a migration corridor during upstream and downstream migration and possibly as rearing habitat. Splittail are not known to spawn in the project area. Splittail spawn in late April and May in Suisun Marsh and between early March and May in the upper Delta and lower reaches of the Sacramento and San Joaquin Rivers (Moyle et al. 1995).

Larval splittail are commonly found in the shallow, vegetated areas where spawning occurs. Larvae eventually move into deeper, open water habitats as they grow and become juveniles. During late winter and spring, young-of-year splittail (i.e., less than 1 year old) are found in sloughs, rivers, and Delta channels near spawning habitat. Juvenile splittail gradually move from shallow, nearshore habitats to the deeper, open water habitats of Suisun and San Pablo Bays (Wang 1986). In areas upstream of the Delta, juvenile splittail can be expected to be present in the flood basins when these areas are flooded during the winter and spring (i.e., Sutter and Yolo Bypasses and the Sacramento River) (Jones & Stokes Associates 1993).

## B.1.12 Coho Salmon—Trinity River

The Southern Oregon/Northern California coho salmon (*Oncorhynchus kisutch*) population in this Evolutionarily Significant Unit (ESU) consists of stocks from the Rogue, Klamath, Trinity, and Eel River basins (60 Federal Register [FR] 24589, May 6, 1997). On May 6, 1997, the National Marine Fisheries Service (NOAA Fisheries) listed Southern Oregon/Northern California coho salmon as a federally threatened species. On April 27, 2001, the California Fish and Game Commission listed the coho salmon as a threatened species.

Critical habitat for the Southern Oregon/Northern California coho salmon was designated on May 5, 1999, and includes all accessible reaches of all rivers (including estuarine areas and tributaries) between the Elk River in Oregon and the Mattole River in California.

## B.1.12.1 Distribution

The Northern California–Southern Oregon coho salmon ESU (coho salmon) occurs on all river reaches from Punta Gorda in Humboldt County, California, to Cape Blanco, Oregon. The coho salmon does not occur in the SDIP project area or in the Sacramento–San Joaquin River basin. Habitat within the Trinity River, however, supports coho salmon and could be affected by changes in water supply operations associated with the SDIP.

## B.1.12.2 Life History and Habitat Requirements

Coho salmon are anadromous fish that migrate as adults into the Trinity River to spawn. Adult migration occurs from mid-September to December, and spawning typically takes place between November and January (Moyle 2002). After hatching, the juveniles move to shallow water along the stream margins (Moyle 2002). Juvenile habitat includes backwaters, side channels, and stream margins adjacent to large, slow runs or pools. Juvenile coho salmon rear for up to 15 months before migrating to the ocean. Downstream migration occurs from March to May, with peak migration occurring in late April through mid-May, when conditions are favorable (Moyle 2002).

## B.1.12.3 Endangerment

Several environmental factors have historically affected the abundance and distribution of the coho salmon. The primary factor leading to the decline of coho salmon statewide is human-caused destruction, modification, or curtailment of habitat. Logging, agriculture, urbanization, stream channelization, wetland loss, unscreened water diversions, mining, and grazing have contributed to the loss of coho salmon.

Logging, mining, and grazing have lead to increased sedimentation that fills in spawning habitat. Increased erosion, loss of riparian habitat, loss of instream woody structure, loss of pool habitat and cover, and channelization effects also affect rearing and holding habitat. Water withdrawals reduce the instream flows, particularly in droughts, thereby reducing the amount of available habitat, as well as increasing water temperatures. (60 FR 38011, July 25, 1995.)

Poor ocean conditions are also suspected to have affected coho salmon populations. Unusually warm ocean surface water temperatures and changes in coastal currents and upwelling have led to reductions in primary and secondary productivity and alterations in prey and predator species distributions. (60 FR 38011, July 25, 1995.)

### B.1.12.4 Occurrence in the Study Area

The coho salmon does not occur in the SDIP project area or in the Sacramento–San Joaquin River basin. Habitat in the Trinity River, however, supports coho salmon and could be affected by changes in water supply operations associated with the SDIP.

## B.1.13 Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) is listed as endangered under the ESA (45 FR 52803). Critical habitat for the valley elderberry longhorn beetle has been designated in two areas: along the American River Parkway Zone and in an area in the Sacramento metropolitan area (45 FR 52803).

The designated critical habitat is outside the study area.

### B.1.13.1 Distribution

The valley elderberry longhorn beetle is found in scattered populations throughout its historical range. The species' range includes most of the Central Valley, north to Trinity County, south to San Diego County, and east to San Bernardino County (Barr 1991).

### B.1.13.2 Life History and Habitat Requirements

Adult beetles feed on elderberry (*Sambucus mexicanus*) foliage and are active from early March to early June. The beetles mate in May and females lay eggs on living elderberry shrubs. Larvae bore through the stems of the shrubs to create an opening in the stem, within which they pupate. After metamorphosing into an adult, the beetle chews a circular exit hole, through which it emerges (Barr 1991). Current information on the habitat of the beetle indicates that it is found only with its host plant, the elderberry. Elderberry shrubs in the Central Valley are commonly associated with riparian habitat but also occur in oak woodlands, savannas, and disturbed areas.

### B.1.13.3 Endangerment

The elderberry is common in the riparian forests of the Central Valley. Urban and agricultural development, as well as aggregate mining and flood control projects, have eliminated a high percentage of these forests, reducing and fragmenting the available habitat for the beetle (Barr 1991).

### B.1.13.4 Occurrence in the Study Area

Elderberry shrub locations were mapped by DWR in the study area during the 2000–2001 vegetation mapping surveys (Spanglet pers. comm.). The vegetation surveys were performed by slowly moving along the waterways in a boat. When an elderberry shrub or cluster was observed, its location was identified using a global positioning system, and the size of the shrub or shrub cluster were recorded. The elderberry surveys did not record the number of stems greater than 1 inch in diameter or whether exit holes were present.

Although USFWS protocol surveys have not been conducted, suitable habitat (i.e., elderberry shrubs) occurs at scattered locations throughout the study area. Elderberry shrubs were observed along Middle River, Old River, and Grant Line Canal, with the highest concentrations occurring along Middle River. No elderberry shrubs were observed at the barrier sites. Elderberry shrubs on Middle River are located in the vicinity of the channel dredging areas. Formal surveys need to be performed (e.g., stem counts and exit holes), and a land-based survey needs to be conduct to determine whether additional shrubs are present.

# B.2 State-Listed Species

## B.2.1 Black-Crowned Night-Heron

The black-crowned night-heron, specifically the rookeries of this species, is identified as a species of special concern by the DFG. There is no federal designation for this species, and no critical habitat has been designated.

### B.2.1.1 Distribution

The black-crowned night-heron is a permanent resident in the Delta. This species is fairly common throughout the valleys and surrounding foothills throughout most of California and is also found along the coast, the Colorado River, and the Salton Sea (Zeiner et al. 1990). It is a summer resident in the northern portions of the Central Valley and northeastern California.

### B.2.1.2 Life History and Habitat Requirements

The black-crowned night-heron's breeding season is from February to July (except in the northeastern portion of the state, where it is from April to August). Nests are made of sticks, debris, or marsh plants and are built either in trees or on the ground (Cogswell 1977). The black-crowned night-heron roosts during the day in dense riparian, upland, or emergent wetland vegetation.

The black-crowned night-heron is mostly nocturnal and a crepuscular feeder. Its diet comprises fish, amphibians, insect larvae, crustaceans, other invertebrates, reptiles, and small mammals (Zeiner et al. 1990). The black-crowned night-heron forages in shallow water along the margins of lakes, large rivers, and fresh and saline emergent marshes and in rice fields.

### B.2.1.3 Endangerment

Human disturbance near nests causes black-crowned night-herons to abandon nests and is therefore a likely cause for decline. Other reasons for decline may include the loss of marshes and other wetlands, use of pesticides, and removal of nesting and roosting trees (Airola 1980).

### B.2.1.4 Occurrence in the Study Area

Black-crowned night-herons have been observed in the study area; however, formal surveys have not been performed to locate rookery sites. There are no known black-crowned night-heron rookeries in the study area (California Natural Diversity Database 2004).

Riparian woodland and riparian scrub and willow scrub in the study area provide suitable nesting and roosting habitat for this species. These land cover types are dominated by native woody riparian tree species that provide potential nest sites for black-crowned night-herons; however, much of this riparian vegetation may be unsuitable for rookery sites because of human disturbance factors (e.g., roadways, boating) and the density of the vegetation.

## B.2.2 California Black Rail

The California black rail is listed as threatened under CESA and is fully protected under the California Fish and Game Code. There is no federal designation for this species, and no critical habitat has been designated.

## B.2.2.1 Distribution

Historically, the California black rail occurred in saline and brackish emergent wetlands in the San Francisco Bay, coastal Marin County, coastal wetlands of southern California, and isolated interior areas of southern California (Grinnell and Miller 1944). The current distribution of the California black rail is restricted to the Delta, Suisun Marsh, San Francisco Bay, isolated tidal and freshwater wetlands in southern California, and the Colorado River (California Department of Fish and Game 1992a). In recent years, the species has also been observed in freshwater marshes in Butte, Nevada, Yuba, and Placer Counties (Aigner et al. 1995).

## B.2.2.2 Life History and Habitat Requirements

The California black rail occupies saline and brackish emergent wetlands and freshwater marshes. The dominant vegetation varies geographically but is generally dominated by pickleweed, cord grass, tules (*Scirpus* spp.), or cattails (*Typha* spp.). Nests are built in the lower portions of emergent wetlands. The California black rail nests from mid-March to July. During winter, black rails may be widely distributed in the marshes and may use the upper marsh vegetation for cover, especially during extreme high tides or high-flow events (Zeiner et al. 1990). The black rail feeds primarily on aquatic and terrestrial invertebrates and is prey to several predators, including herons and domestic cats (Zeiner et al. 1990).

## B.2.2.3 Endangerment

California black rail populations have primarily declined as a result of habitat loss. Many of the remaining marshes in the Delta lack extensive high marsh habitat and have steep earthen levees, making them unsuitable for rails. Additionally, pollution from sewage effluent, industrial discharges, and urban runoff has contaminated the species' food sources. California black rail populations may also be subject to increased predation from natural predators, as well as introduced predators and feral animals.

## B.2.2.4 Occurrence in the Study Area

The California black rail has not been observed in the study area; however, potential habitat exists in the study area. Potential habitat includes emergent marsh habitat located on the perimeter of in-channel islands and expansive areas of emergent marsh adjacent to levees. This species has been recorded in in-channel marshes along Old River in the vicinity of the study area (California Natural Diversity Database 2004), although no formal surveys have been performed for this species under the South Delta Improvements Program. High-flow events during the winter may affect potential populations of this species because suitable high marsh habitat may not be available as refugia from such events.

# B.2.3 Cooper's Hawk

The Cooper's hawk is listed as a species of special concern under CESA and as a species of concern under the ESA. No critical habitat has been designated.

## B.2.3.1 Distribution

The Cooper's hawk is found throughout most of the United States, as well as southern Canada and northern Mexico. It is believed that northern populations are migratory and southern populations are resident; however, some southern populations apparently migrate as well (Rosenfield and Bielefeldt 1993). The historical range of the Cooper's hawk in California is similar to its current range; however, the species is less common in the Central Valley than it was historically. The Cooper's hawk breeds throughout most of California in a variety of woodland habitats, including riparian and oak woodlands (Zeiner et al. 1990). The highest densities probably occur in the foothill oak woodlands of the Sierra Nevada and Transverse Ranges (Asay 1987).

## B.2.3.2 Life History and Habitat Requirements

This species nests in deciduous, coniferous, and mixed woodlands (Garrett and Dunn 1981) but has also been reported to nest in urban areas (Palmer 1988). Cooper's hawks often nest and forage near open water or riparian vegetation. Prey comprises small birds, a variety of small mammals, reptiles, and amphibians (Zeiner et al. 1990). Pairs generally return to the same territory year after year and will often build a new nest in the vicinity of the existing one (Reynolds and Wight 1978).

## B.2.3.3 Endangerment

In California, declines in Cooper's hawk populations have been attributed to habitat loss, particularly of lowland riparian areas (Remsen 1978). Pesticides, which have been attributed to the decline of eastern populations of this species, may also play a role in the decline of western populations.

## B.2.3.4 Occurrence in the Study Area

Although the Cooper's hawk has not been observed in the study area and formal surveys have not been performed, this species is expected to be a permanent resident in the study area. This species is also expected to occur as a transient and winter resident in the study area. Riparian woodland in the study area provides suitable nesting and roosting habitat for this species.

# B.2.4 Great Blue Heron

The great blue heron, specifically the rookeries of this species, is identified as a species of special concern by the DFG. There is no federal designation for this species. No critical habitat has been designated.

## B.2.4.1 Distribution

The great blue herons is fairly common throughout most of California year round in shallow estuaries and fresh and saline emergent wetlands. Great blue herons are permanent residents in the Delta. This species winters throughout the Central Valley, Suisun Marsh, and San Francisco Bay Area. The Central Valley and San Francisco Bay Area is considered a key wintering area in North America for great blue herons (Mikuska et al. 1998).

## B.2.4.2 Life History and Habitat Requirements

The great blue heron arrives on the breeding grounds in February. Eggs are laid in late February or March. In June or July, after breeding, individuals disperse from the nesting colonies to outlying areas, but there is little regular migration (Gill and Mewaldt 1979). Great blue heron nests are similar to and are often in mixed colonies with great egrets (Cogswell 1977). Herons usually nest in colonies in the tops of secluded large snags or live trees, usually among the tallest trees available (Zeiner et al 1990).

Great blue herons require habitat containing fish-bearing waters because their diet consists primarily of fish. They also eat crustaceans, frogs, salamanders, lizards, snakes, large aquatic insects, and small rodents (Cogswell 1977). The species is active year round and feeds both night and day but is most active at dawn and dusk (Terres 1980).

## B.2.4.3 Endangerment

Human disturbance near nests causes great blue herons to abandon nests and is therefore most likely a cause for decline. The species is also probably sensitive to pesticides and herbicides in nesting and foraging areas (Jackman and Scott 1975). Populations in California increased from 1970 to 1978 (Belluomini 1978).

### B.2.4.4 Occurrence in the Study Area

Great blue herons have been observed in the study area; however, formal surveys have not been performed to locate rookery sites. A CNDDB record search identified one occurrence of a great blue heron rookery in the study area (California Natural Diversity Database 2004). This rookery, which was recorded in 2000, is located on an island in Middle River, near the confluence of the Mokelumne Aqueduct, approximately 5 miles from the proposed Middle River barrier.

Cottonwood willow woodland and valley oak riparian woodland are present in the study area. These land cover types are dominated by native woody riparian tree species that provide potential nest sites for great blue herons; however, much of this riparian vegetation may be unsuitable for rookery sites because of human disturbance factors (e.g., roadways, boating).

## B.2.5 Great Egret

The great egret, specifically the rookeries of this species, is identified as a species of special concern by the DFG. There is no federal designation for this species. No critical habitat has been designated

### B.2.5.1 Distribution

The great egret is a permanent resident in the Delta. The species is fairly common throughout most of California and breeds at scatter locations in the Central Valley and locally in coastal regions and along the Colorado River (McCrimmon et al. 2001).

### B.2.5.2 Life History and Habitat Requirements

Great egrets nest in colonies in the tops of secluded large snags or live trees. Great egret nests are similar to and are often in mixed colonies with great blue herons (Cogswell 1977). Great egrets require groves of trees that are suitable for nesting and roosting, relatively isolated from human activities, and near aquatic foraging areas. Great egrets typically nest from March to July, and populations are concentrated near nesting colonies.

Nests are constructed from sticks and stems of marsh plants and are built in large trees and lined with leafy materials (Zeiner et al. 1990; McCrimmon et al.). Great egrets forage in fresh and saline emergent wetlands; along the margins of lakes, slow-moving rivers, and streams; and on irrigated croplands and pastures. Great egrets primarily eat fishes, amphibians, snakes, snails, crustaceans, insects, and small mammals (Zeiner et al. 1990).

### B.2.5.3 Endangerment

Human disturbance near nests causes great egrets to abandon nests and is therefore a likely cause for decline. High winds often destroy eggs, nests, and nestlings (Page 1971; Ives 1972; McCrimmon et al. 2001). Eggshell thinning resulting from pesticide intake may also reduce breeding success (Ives 1972). Additionally, wetland drainage has markedly reduced available foraging habitat for the species (Zeiner et al. 1990).

### B.2.5.4 Occurrence in the Study Area

Great egrets are known to occur in the study area; however, formal surveys have not been performed to locate rookery sites. There are no known great egret rookeries in the study area (California Natural Diversity Database 2004).

Cottonwood willow woodland and valley oak riparian woodland are present in the study area. These land cover types are dominated by native woody riparian tree species that provide potential nest sites for great egrets; however, much of this riparian vegetation may be unsuitable for rookery sites because of human disturbance factors (e.g., roadways, boating).

## B.2.6 Greater Sandhill Crane

The greater sandhill crane is listed as threatened under CESA and is a fully protected species under the California Fish and Game Code. This species is federally designated as a species of concern under the ESA. No critical habitat has been identified for this species.

### B.2.6.1 Distribution

The greater sandhill crane occurs in the study area as a winter resident. It is estimated that between 3,400 and 6,000 greater sandhill cranes winter in the Sacramento Valley and Delta (Pogson and Lindstedt 1991; California Department of Fish and Game 2000; Pacific Flyway Council 1997). In California, nesting populations have been observed in Lassen, Modoc, Plumas, Shasta, Sierra, and Siskiyou Counties (Ivey and Herziger 2001).

### B.2.6.2 Life History and Habitat Requirements

During winter, the greater sandhill crane feeds on grasses, forbs, waste grains, small mammals, amphibians, snakes, and invertebrates (Zeiner et al. 1990). It feeds and roosts in pastures, flooded and unflooded grain fields, and seasonal wetlands. The greater sandhill crane nests in open areas of wet meadows that are often interspersed with emergent marsh and usually build its nest over shallow water. During the nesting season, it feeds on a wide variety of invertebrates, amphibians, and small mammals.

### B.2.6.3 Endangerment

Greater sandhill crane populations have declined for a variety of reasons, including loss of breeding and wintering habitats, human disturbance at nesting sites, collision with power lines, predation, and mower-caused mortality on the breeding grounds (Littlefield 1982; Littlefield et al. 1994; California Department of Fish and Game 2000).

### B.2.6.4 Occurrence in the Study Area

The greater sandhill crane may occur as a winter resident in the study area; however, the study area is outside of the species' traditional wintering areas in the Delta. Suitable winter foraging habitat is present on agricultural and pasture lands in the study area. Greater sandhill cranes have not been observed in the study area, and formal winter surveys have not been performed for this species.

## B.2.7 Northern Harrier

The northern harrier is listed as a species of special concern under CESA. There is no federal designation for this species, and no critical habitat has been designated.

### B.2.7.1 Distribution

Historically, the northern harrier bred throughout California, except in deserts, woodlands, and forested mountains. Breeding localities in California included the interior valleys, from Siskiyou County south to western Riverside and San Bernardino Counties, and coastal regions from Marin County to San Diego County (Grinnell and Miller 1944). There are currently two main populations of northern harriers in California: one at the Klamath Basin refuges and the other in the Delta. The breeding range of the Delta population includes most of the Central Valley, Delta, Suisun Marsh, and portions of the San Francisco Bay (Zeiner et al. 1990).

### B.2.7.2 Life History and Habitat Requirements

The northern harrier nests and roosts in tall grasses and forbs in wetlands and field borders (Zeiner et al. 1990). It will roost on the ground in shrubby vegetation, often near the marsh edge (Brown and Amadon 1968). The northern harrier's breeding season is between April and September, with peak activity in June and July. The northern harrier feeds mainly on voles and other small mammals, birds, small reptiles, crustaceans, and insects.

### B.2.7.3 Endangerment

Northern harrier populations in the Delta declined primarily because of extensive draining of wetlands, implementation of monoculture farming, and reforestation of open farmlands (MacWhirter and Bildstein 1996). Northern harrier populations appear to exhibit variable, but possibly decreasing, trends in western North America, primarily as a result of wetlands loss (White 1994).

### B.2.7.4 Occurrence in the Study Area

Although formal surveys have not been performed for this species, northern harriers have been observed in the study area and are known to nest in at least one location near the northeast portion of the CCF (Rooks pers. comm.). Suitable nesting habitat may occur in ruderal and wetland habitats throughout the study area. Foraging habitat occurs throughout the study area in adjacent agricultural and pasture lands.

## B.2.8 Short-Eared Owl

The short-eared owl is listed as a species of special concern under CESA and as a migratory nongame bird of management concern by the USFWS. No critical habitat has been designated for this species.

### B.2.8.1 Distribution

Historically, the short-eared owl bred throughout California in areas west of the deserts (Grinnell and Miller 1944). The short-eared owl population has declined dramatically throughout the state. Breeding populations have been extirpated from the southern coast and from the San Joaquin Valley (Remsen 1978). The species still breeds in the southern portion of the Sacramento Valley (Yolo and Solano Counties), the Delta, Suisun Marsh, northeastern portions of the state, the Coast Ranges from Sonoma to Santa Barbara Counties, and in the Owens Valley (Small 1994; Zeiner et al. 1990).

### B.2.8.2 Life History and Habitat Requirements

The short-eared owl is generally a migratory species, although it is resident in portions of California (Zeiner et al. 1990). Short-eared owls are more numerous in winter, with migrating birds arriving in September and October and leaving in April (Zeiner et al. 1990). The breeding season is from late March to July (Zeiner et al. 1990). Nests are built on the ground in tall stands of grasses in lowland habitats near hunting grounds in marshes, meadows, and even agricultural fields (Grinnell and Miller 1944). The primary food source of short-eared owls is small mammals.

### B.2.8.3 Endangerment

The destruction of breeding and foraging habitat has been the primary cause of declines in short-eared owl populations. In some areas with appropriate habitat in tact, grazing and shooting have also led to further declines (Remsen 1978).

### B.2.8.4 Occurrence in the Study Area

Although potential nesting and roosting habitat for the short-eared owl occurs in ruderal habitats throughout the study area, breeding populations have been extirpated from the southern coast and from the San Joaquin Valley, and there are no known recent nesting occurrences in the study area. No formal surveys have been performed for this species in the study area. Agricultural and pasture lands in the study area provide suitable foraging areas for this species. The study area provides suitable roosting and foraging wintering habitat for this species, and short-eared owls have been observed on the west side of the CCF adjacent to Italian Slough (Rooks pers. comm.).

## B.2.9 Snowy Egret

The snowy egret, specifically the rookeries of this species, is identified as a species of special concern by the DFG. There is no federal designation for this species, and no critical habitat has been designated.

### B.2.9.1 Distribution

The snowy egret is a permanent resident in the Delta. Snowy egrets are fairly common throughout most of lowland and coastal California. This species breeds at scatter locations in the Central Valley, northeastern California, and coastal regions and along the Salton Sea and the Colorado River (Parsons and Masters 2000).

### B.2.9.2 Life History and Habitat Requirements

Snowy egrets nest in single-species or mixed-species colonies (Parsons and Master 2000). Nests are built in low, dead trees or shrubs out of sticks and the stems of marsh plants. Nests may be built near freshwater lakes or on the banks of marshes out of tules (Cogswell 1977). The breeding season is from late March to mid-May in southern and central California and late April through late August in northern California (Zeiner et al. 1990).

Snowy egrets are often observed in saltwater marshes, tidal lagoons, and tidal estuaries and along the banks of lakes, rivers, and streams hunting for food. Snowy egrets feed on a wide variety of prey, including fish, crayfish and other crustaceans, reptiles, amphibians, aquatic and terrestrial insects, and small mammals (Parsons and Master 2000; Zeiner et al. 1990).

### B.2.9.3 Endangerment

Human disturbance near nests may cause snowy egrets to abandon nests and is therefore a likely cause for decline. Other reasons for decline may include the loss of suitable nesting and foraging areas and wetland degradation from chemical contamination (Parsons and Master 2000).

### B.2.9.4 Occurrence in the Study Area

Snowy egrets are expected to occur in the study area; however, formal surveys have not been performed to locate rookery sites. There are no known snowy egret rookeries in the study area (California Natural Diversity Database 2004). The riparian woodland, riparian scrub, and willow scrub land cover types in the study area provide potential nest sites for snowy egrets; however, much of this riparian vegetation may be unsuitable for rookery sites because of human disturbance factors (e.g., roadways, boating) and the density of the vegetation.

## B.2.10 Swainson's Hawk

The Swainson's hawk is listed as threatened under CESA and as a species of concern under the ESA. No critical habitat has been designated for this species.

### B.2.10.1 Distribution

Swainson's hawks breed from southwestern Canada to northern Mexico (Godfrey 1986; Howell and Webb 1995; England et al. 1997). Nearly all North American populations of Swainson's hawks winter in South America and

Mexico; however, a few birds regularly winter in southern Florida (Stevenson and Anderson 1994) and in the Delta (Yee et al. 1991; Herzog 1996).

The historical breeding range of the Swainson's hawk in California included the Great Basin; the Sacramento and San Joaquin Valleys; along the coast in Marin, Monterey, Ventura, Los Angeles, and San Diego Counties; on Catalina Island; and a few scattered locations in the Colorado and Mojave Deserts (Bloom 1980). Swainson's hawks continue to nest in most of the previously occupied regions of the state; however, they have been extirpated in coastal central and southern California. Currently the number of breeding birds has been greatly reduced throughout major portions of the species' range (Bloom 1980; California Department of Fish and Game 1994). Observations of wintering Swainson's hawks in the Delta have occurred annually since 1991 (Yee et al. 1991; Herzog 1996).

It is estimated that the breeding population of Swainson's hawks in California has declined by more than 90% from historical times (Bloom 1980). Surveys done in California during the 1990s indicate that the statewide population estimate is 500–1,000 breeding pairs, approximately 80% of which are in the Central Valley. Yolo, San Joaquin, and Sacramento Counties are the most important nesting areas that remain in the state (California Department of Fish and Game 1994).

## B.2.10.2 Life History and Habitat Requirements

The Swainson's hawk nests almost exclusively in only a few species of trees (Schlorff and Bloom 1983). In a study of movements and habitat use, it was found that single trees or riparian areas were used most often for nesting (Estep 1989). A survey of nesting birds in California during 1979 revealed that the Swainson's hawk nested almost exclusively in large, sparsely vegetated flatlands characterized by valleys, plateaus, broad floodplains, and large expanses of desert (Bloom 1980).

The natural foraging habitat of the Swainson's hawk is relatively open, grass-dominated vegetation and sparse shrublands. The Swainson's hawk can forage in many crops but appears to be more abundant in areas of moderate cultivation than in either grassland or areas of extensive cultivation (Schmutz 1987). The ability of the Swainson's hawk to use cultivated lands for foraging is a complex interaction of crop phenology and cultural practices (Schmutz 1987; Estep 1989; Woodbridge 1991). Orchards and vineyards, in general, are not suitable foraging habitat for the Swainson's hawk because of the dense woody cover, and rice is unsuitable most of the season because it is flooded (Estep 1989).

The Swainson's hawk migrates long distances, is highly gregarious, and is largely insectivorous during migration. During the breeding season, small mammals are the primary prey items (Estep 1989). Swainson's hawks from the Central Valley winter primarily in Mexico but have also been tracked to Central America and Columbia. It typically return to nest sites in California from early

March to April (later in more northern areas of the state). Migratory flocks begin to form in late August and September, and most birds are on the wintering grounds by November (Bradbury pers. comm.).

### B.2.10.3 Endangerment

Several factors are expected to have contributed to the decline in Swainson's hawk populations, including loss or degradation of breeding habitat in the Central Valley, disturbance on the breeding grounds, mortality during migration and on the wintering grounds in Central and South America, poisoning or pesticide contamination on the wintering grounds, eggshell thinning, and increased competition with other species.

### B.2.10.4 Occurrence in the Study Area

The Swainson's hawk has been observed in the study area and is known to nest in several locations, including within the vicinity of the Middle, Old River, and Grant Line barrier sites and the proposed channel dredging areas (California Natural Diversity Database 2004; Rooks pers. comm.). Suitable nest trees occur throughout most of the study area on in-channel islands, on levees, and on adjacent lands. Suitable foraging habitat occurs on adjacent agricultural and pasture lands. Wintering birds may also be present in the study area, although in far fewer numbers than during the breeding season.

Formal surveys were performed for the Temporary Barrier Project, the Interim South Delta Program, the South Delta Improvements Program, and the Swainson's Hawk Conservation Program from 1993 to 2001. Surveys were performed by boat and car along all waterways potentially affected by the project. Saturation surveys, to a distance of ½-mile radius from the proposed activity, have been performed around the barrier sites since 1996 and around the west side of the CCF since 1998. There are 55 known territories and 10 additional territories along waterways in the project area, including active territories in the study area (Bradbury pers. comm.)

## B.2.11 Tricolored Blackbird

The tricolored blackbird is listed as a species of special concern under CESA and as a species of concern under the ESA. No critical habitat has been designated for this species.

### B.2.11.1 Distribution

The tricolored blackbird is largely endemic to California. In any given year, more than 75% of the breeding population occurs in the Central Valley (Hamilton 2000). Tricolored blackbird breeding colonies have been observed in all Central Valley counties (Beedy and Hamilton 1997, 1999; Hamilton 2000). Small breeding populations also exist at scattered sites in Oregon, Washington, Nevada, and western coastal Baja California (Beedy and Hamilton 1999).

Population surveys and banding studies of tricolored blackbirds in the Central Valley from 1969 to 1972 concluded that the species' geographic range and major breeding areas were unchanged in 35 years (DeHaven et al. 1975); however, the study also concluded that the overall population size had declined by more than 50% since the 1930s. It should be noted that this study did not survey large portions of the southern San Joaquin Valley; therefore, the population decline may be somewhat exaggerated.

Local, regional, and statewide tricolored blackbird populations have experienced serious declines since 1994. Volunteer survey results (summarized by Hamilton et al. 1995, Beedy and Hamilton 1997, and Hamilton 2000) have identified several important distribution and population trends for the tricolored blackbird:

- local, regional, and statewide populations and distributions vary from year to year;
- 60% of all tricolored blackbirds located in all years were found in the 10 largest colonies;
- 70% of all tricolored blackbird nests and 86% of all foraging by nesting birds were on private agricultural lands; and
- in some portions of its range, the tricolored blackbird has definitely declined or been eliminated, including local extirpation in most of Yolo County and portions of southern Sacramento County.

### B.2.11.2 Life History and Habitat Requirements

The tricolored blackbird has three basic requirements for selecting its breeding colony site: open, accessible water; a protected nesting substrate, including either flooded, thorny, or spiny vegetation; and a suitable foraging space that provides adequate insect prey within a few miles of the nesting colony (Hamilton et al. 1995; Beedy and Hamilton 1997, 1999).

Almost 93% of the 252 tricolored blackbird breeding colonies reported by Neff (1937) were in freshwater marshes dominated by tules and cattails; the remaining colonies were in willows, blackberries (*Rubus* spp.), thistles (*Cirsium* and *Centaurea* spp.), or nettles (*Urtica* spp.). In contrast, only 53% of the colonies reported during the 1970s were in cattails and tules (DeHaven et al. 1975). An increasing percentage of colonies in the 1980s and 1990s were reported in

Himalaya blackberries (*Rubus discolor*) (Beedy et al. 1991), and some of the largest recent colonies are in silage and grain fields (Hamilton et al. 1995; Beedy and Hamilton 1997; Hamilton 2000).

Tricolored blackbird foraging habitats include annual grasslands; wet and dry vernal pools and other seasonal wetlands; agricultural fields, such as large tracts of alfalfa with continuous mowing schedules and recently tilled fields; cattle feedlots; and dairies. Tricolored blackbirds also forage occasionally in riparian scrub habitats and along marsh borders. Weed-free row crops and intensively managed vineyards and orchards do not serve as regular foraging sites. (Beedy and Hamilton 1997, 1999.)

Most tricolored blackbirds forage within 3 miles (5 kilometers) of their colony sites (Orians 1961), but commute distances of up to 8 miles (13 kilometers) have been reported (Beedy and Hamilton 1999). Short-distance foraging (i.e., within sight of the colony) for nestling provisioning is also common. Tricolored blackbirds are opportunistic foragers (Beedy and Hamilton 1999). Animal matter, predominantly insects and spiders, composes the bulk of the nestling and fledgling diet; adults tend to consume more animal matter in spring and summer and more vegetable matter, such as seeds and cultivated grains, in fall and winter.

### B.2.11.3 Endangerment

The decline in tricolored blackbird populations can be attributed to habitat loss and alteration, predation by numerous mammalian and avian species, contaminants and pollution, and human disturbance (Beedy and Hamilton 1997). Predation is presently (i.e., 1985–1995) a major cause of complete nesting failure at some tricolored blackbird colonies (Hamilton et al. 1995; Beedy and Hayworth 1992). Tricolored blackbirds are also sensitive to human disturbance of active nesting colonies.

### B.2.11.4 Occurrence in the Study Area

Historically, the tricolored blackbird nested near the Old River barrier site, and nest colonies likely occurred throughout the study area within suitable habitats. No tricolored blackbirds were observed during incidental surveys performed by DWR between 1992 and 2001 (Rooks pers. comm.). Potential nesting habitat is present in extensive emergent wetland or Himalaya blackberry stands throughout the study area. No suitable habitat is available at the barrier sites.

## B.2.12 Western Burrowing Owl

The western burrowing owl is listed as a species of special concern under CESA and a species of concern under the ESA. No critical habitat has been designated for this species.

### B.2.12.1 Distribution

The western burrowing owl is a permanent resident throughout most of California. This species was historically more abundant, but since the 1940s, numbers have been declining in all areas. In the San Francisco Bay Area and central portion of the Central Valley (i.e., Yolo and Sacramento Counties south to Merced County), the burrowing owl population has declined by 65% since 1986 (DeSante pers. comm.).

### B.2.12.2 Life History and Habitat Requirements

The burrowing owl is typically found in dry grassland, agricultural, and desert habitats and occasionally inhabits seacoast bluffs (Small 1994). This species nests in abandoned ground squirrel and other small mammal burrows (Zeiner et al. 1990). The burrowing owl primarily preys on insects and small mammals; however, arachnids, amphibians, and reptiles are also taken. The owl's breeding season is from March to August, peaking in April and May.

### B.2.12.3 Endangerment

Habitat loss, primarily the conversion of grassland habitat for agricultural and urban uses, is the greatest threat to burrowing owls. Additional causes of decline include pesticide use in nesting areas, rodent control programs, and habitat fragmentation (Remsen 1978).

### B.2.12.4 Occurrence in the Study Area

Potential habitat for the burrowing owl occurs in ruderal habitats and in the vicinity of agricultural lands throughout the study area. DWR conducted formal surveys for burrowing owls along the CCF. Nesting burrowing owls were observed on the northwest side of the forebay (Rooks pers. comm.). No burrowing owls were observed at the barrier sites during incidental surveys performed by DWR between 1996 and 2001. DWR performed formal surveys for the Old River–Tracy DMC barrier in 1998. Although no owls or burrows were observed, this area may provide foraging habitat for this species. Burrowing owls may also occur in the sediment removal areas.

## B.2.13 White-Tailed Kite

The white-tailed kite is a fully protected species under the California Fish and Game Code and is listed as a species of concern under the ESA. No critical habitat has been designated for this species.

### B.2.13.1 Distribution

White-tailed kite populations have fluctuated greatly over the past century. This species was common and widespread in valley and foothills of the Central Valley before 1895, but, by the 1940s, it was rare or entirely gone from many areas (Grinnell and Miller 1944). Between the 1940s and the 1970s, kite populations increased, and its range extended north into Oregon, south into Central America, and east into Texas (Shuford 1993). The white-tailed kite has steadily decreased throughout much of California since the late 1970s, especially in southern California (Garrett and Dunn 1981), along the southern coast (Marantz 1986), and in the San Joaquin Valley (Small 1994). Local populations appear to still be relatively healthy along the north and east San Francisco Bay and in the Delta.

### B.2.13.2 Life History and Habitat Requirements

The white-tailed kite inhabits open lowland grassland, riparian woodland, marshes, and scrub areas. Some large shrubs or trees are required for nesting. The white-tailed kite depends on small rodents that have highly cyclical populations. Communal night roosting is common during the nonbreeding season.

### B.2.13.3 Endangerment

Declines in white-tailed kite populations during the early part of the 1900s were probably the result of habitat loss, shooting, and, to a much lesser extent, egg collecting (Shuford 1993). The most important threat still facing this species is loss of habitat, including conversion of agricultural lands to urban/residential land uses. Although kites appear able to withstand some habitat alteration from grazing and farming, large stretches of agricultural areas devoid of natural vegetation and urbanized areas are not suitable habitat. However, declines have occurred even where agricultural lands have experienced little conversion. Kite populations also fluctuate greatly with cycles of prey abundance, which, in turn, correlate significantly with rainfall (Pruett-Jones et al. 1980). These fluctuations make it difficult to determine long-term population trends.

### B.2.13.4 Occurrence in the Study Area

Although no formal surveys have been performed, white-tailed kites have been observed in the study area. No nesting activity has been observed; however, suitable nest sites are present throughout the study area. Suitable nest trees occur throughout most of the study area on in-channel islands, levees, and adjacent lands. Suitable foraging habitat occurs on adjacent agricultural and pasture lands, and kites have been observed foraging in the vicinity of the CCF (Rooks pers. comm.).

# B.2.14 Western Pond Turtle

The western pond turtle (*Clemmys marmorata*) is listed as a species of special concern under CESA and as a species of concern under the ESA. No critical habitat is designated for this species.

## B.2.14.1 Distribution

The western pond turtle is the only abundant turtle native to California (Zeiner et al. 1988). It was historically found in most Pacific slope drainages between the Oregon and Mexican borders (Jennings and Hayes 1994). The species is still found in most suitable habitats west of the Sierra-Cascade crest in California, but trends show populations to be declining (Jennings and Hayes 1994).

## B.2.14.2 Life History and Habitat Requirements

The western pond turtle occurs in permanent or nearly permanent waters with little or no current (Behler and King 1998). The channel banks of inhabited waters usually have thick vegetation, but basking sites, such as logs, rocks, or open banks, must also be present (Zeiner et al. 1988).

The western pond turtle may become inactive during winter or remain active year-round, depending on latitude, elevation, and habitat type. Eggs are laid in nests along sandy banks of large, slow-moving streams or in upland areas, including grasslands, woodlands, and savannas. Nest sites are typically found on a slope that is unshaded and has a high clay or silt content in soil at least 4 inches deep (Jennings and Hayes 1994). Eggs are laid from March to August, depending on local conditions. Incubation lasts from 73 to 80 days (Zeiner et al. 1988). The western pond turtle is omnivorous and feeds on aquatic plant material, aquatic invertebrates, fishes, frogs, and even carrion (Zeiner et al. 1988).

## B.2.14.3 Endangerment

The loss and alteration of wetlands, streams, and ponds has contributed to the species' decline. Dam construction has led to alteration of channels and flow rates and reduced the amount of suitable habitat for western pond turtles (Reese and Welsh 1988). Nesting sites may also be affected during the incubation period by agricultural or livestock activities, leading to annual nesting failures or reduced success (Jennings and Hayes 1994).

### B.2.14.4 Occurrence in the Study Area

The western pond turtle occurs throughout the study area, including in the barrier sites and the sediment removal sites (California Natural Diversity Database 2004; Patterson pers. comm.). DWR conducted formal surveys by boat in summer 2000 and 2001. Surveys were completed at various times throughout the day and during different periods in the tidal cycle. Turtles were observed throughout the study area in varying densities and were found at the barrier sites, the sediment removal areas, and around the CCF (Patterson pers. comm.).

## B.2.15 Suisun Marsh Aster

The Suisun Marsh aster (*Aster lentus*) is categorized as List 1B by the California Native Plant Society (CNPS). There is no federal designation for this species, and no critical habitat has been designated.

### B.2.15.1 Distribution

The Suisun Marsh aster is endemic to California. Historically, the range of this species most likely included the margins of northern San Francisco Bay, Suisun Marsh, and the lower Delta. The current distribution of this species extends from Suisun Marsh east through the western and central regions of the Delta. Approximately 124 known occurrences of Suisun Marsh aster are recorded in Contra Costa, Solano, San Joaquin, Sacramento, and Napa Counties (California Natural Diversity Database 2004). These occurrences vary in size from 1 to more than 130 plants and are found on private property and public lands managed by the DFG, DPR, and Sacramento County (California Natural Diversity Database 2004).

### B.2.15.2 Life History and Habitat Requirements

The Suisun Marsh aster is a slightly succulent perennial herb of the sunflower family (*Asteraceae*) that grows to more than 3 feet tall (Allen 1993). This species inhabits tidal streams and freshwater and brackish marshes throughout the lower Delta. It typically occurs along sloughs and riverbanks affected by tidal fluctuations, usually around the mid- to high-tide mark. Although most commonly found on the water side of Delta and marsh levees, it also occurs on the landward side of levees along irrigation and drainage ditches (California Department of Water Resources 1994). The flowering period for the Suisun Marsh aster is from late May to November (California Native Plant Society 2001).

### B.2.15.3 Endangerment

One reason for decline of Suisun Marsh aster is the loss of habitat, including loss caused by marsh alteration, livestock trampling, recreational use, levee repair and maintenance, levee revetment, and competition from nonnative plants (California Natural Diversity Database 2004; California Native Plant Society 2001).

### B.2.15.4 Occurrence in the Study Area

Suisun Marsh aster is a perennial herb that occurs in brackish and freshwater tidal emergent wetland habitat along sloughs and rivers, usually at or near the water's edge, or within drainage and irrigation ditches (California Native Plant Society 2001; California Department of Water Resources 1994). Approximately 134 acres of tule and cattail tidal emergent wetland, which is suitable habitat for Suisun Marsh aster, have been identified in the study area, and 22 acres are in the project construction area. However, surveys conducted in June–September of 2000 and 2001 did not locate any occurrences of Suisun Marsh aster in the study area.

There are 125 CNDDB-recorded occurrences for Suisun Marsh aster throughout its range and 76 occurrences within the Delta region (California Natural Diversity Database 2004). The nearest CNDDB-recorded occurrence of Suisun Marsh aster to the project area includes two locations at the confluence of Old River and Rock Slough, more than 5 miles north of the proposed Old River dredging area (California Natural Diversity Database 2004). One location is on an in-channel island, and the other is on the slough bank. The plants occur in tidal emergent wetland habitat in association with goldenrod, blackberry, dallisgrass, and pampas grass. Only 10 plants were observed at this occurrence in 1986.

## B.2.16 Slough Thistle

Slough thistle (*Cirsium crassicaule*) is categorized as List 1B by the CNPS. There is no federal designation for this species, and no critical habitat has been designated.

### B.2.16.1 Distribution

Slough thistle is endemic to Kern, King, and San Joaquin Counties. There are 17 known occurrences on private land as well as public lands administered by the U.S. Department of Defense, USFWS, and DPR (California Natural Diversity Database 2004). Population sizes of slough thistle appear to fluctuate widely from year to year (California Native Plant Society 2001).

### B.2.16.2 Life History and Habitat Requirements

Slough thistle is an annual or biennial species of the sunflower family that typically grows 3–10 feet (1–3 meters) tall. The species is found in chenopod scrub, marshes and swamps (sloughs), and riparian scrub at elevations ranging from 10 to 330 feet (3 to 100 meters). Slough thistle produces pale purple to white flowers and generally blooms from May to August (Keil and Turner 1993; California Native Plant Society 2001).

### B.2.16.3 Endangerment

Slough thistle is threatened by the invasion of nonnative plants and by loss of habitat to agriculture (California Native Plant Society 2001).

### B.2.16.4 Occurrence in the Study Area

Slough thistle is an annual herb endemic to Kern, King, and San Joaquin Counties. This thistle occurs in three habitat types: nontidal emergent wetland (usually seasonally wet, but also one known location in a perennial marsh), riparian scrub, and chenopod scrub. Suitable habitat for slough thistle is present within riparian scrub and willow scrub habitats. Approximately 248 acres of these habitats have been mapped in the study area, and 99 acres are within the project construction area. Seasonally inundated agricultural ditches in the study area may also be considered suitable habitat for this species. Because slough thistle has not been recorded in any tidal habitats, the tule and cattail tidal emergent wetland in the project area is not considered suitable habitat. Surveys conducted in June–September of 2000 and 2001 did not locate any occurrences of slough thistle in the study area.

Slough thistle is known from 19 CNDDB-recorded occurrences throughout its range and two occurrences within the Delta region (California Natural Diversity Database 2004). Population sizes of slough thistle appear to fluctuate widely from year to year (California Native Plant Society 2001). The nearest CNDDB-recorded occurrence of slough thistle to the project area was last seen in 1933 at the confluence of Old River and San Joaquin River in an area of intensive agriculture, but this population may be extirpated (California Natural Diversity Database 2004).

## B.2.17 Delta Coyote-Thistle

Delta coyote-thistle (*Erysimum capitatum* ssp. *angustatum*) is state listed as endangered and categorized as a List 1B species of concern by the CNPS. There is no federal designation for this species, and no critical habitat has been designated.

## B.2.17.1 Distribution

Delta coyote-thistle's historical distribution includes Calaveras, Merced, Stanislaus, and San Joaquin Counties. Of the approximately 26 occurrences recorded in the CNDDB, seven are possibly extirpated, including all occurrences in San Joaquin County and most in Stanislaus County. Most extant occurrences are found in Merced County along the San Joaquin River, and one occurrence is in Stanislaus County on the margin of Turlock Lake. Extant populations vary from 1 to 12,000 plants. (California Natural Diversity Database 2004.)

## B.2.17.2 Life History and Habitat Requirements

Delta coyote-thistle is an herbaceous, perennial herb of the carrot family (Apiaceae). It occurs in seasonally wet depressions in riparian scrub from 10 to 100 feet (3 to 30 meters) above sea level and generally blooms from June to August (California Native Plant Society 2001). Delta coyote-thistle occurs on clay soils on sparsely vegetated margins of seasonally flooded floodplains and swales, freshwater marshes, and riparian areas. Suitable habitat is supported by periodic flooding, which maintains seasonal wetland hydrology and reduces competition through scouring (California Department of Fish and Game 1998).

## B.2.17.3 Endangerment

Flood control activities and conversion of lowlands to agriculture have affected many populations of Delta coyote-thistle. Friant Dam on the San Joaquin River and an extensive levee system have greatly reduced the frequency and flooding of floodplain habitat. Riparian restoration or waterfowl enhancement projects could also threaten the species if habitat areas are artificially flooded during critical stages in the life cycle (California Department of Fish and Game 1998; California Native Plant Society 2001; California Natural Diversity Database 2004).

## B.2.17.4 Occurrence in the Study Area

Approximately 248 acres of riparian scrub and willow scrub habitat have been mapped in the study area, and 99 acres are within the project construction area. The actual acreage of wet depressions within these habitats is not quantified but will be less than the total area of the scrub habitats delineated in the project area. Surveys conducted in June–September of 2000 and 2001 did not locate any occurrences of Delta coyote-thistle in the study area.

There are 26 CNDDB-recorded occurrences for Delta coyote-thistle throughout its range and 4 occurrences within the Delta region (California Natural Diversity Database 2004). The species is recorded within 1 mile of the project area, in an area that floods and is occupied by a walnut orchard, but this occurrence may have been extirpated (California Natural Diversity Database 2004).

# B.2.18 Rose-Mallow

Rose-mallow (*Hibiscus lasiocarpus*) is categorized as List 2 by the CNPS. There is no federal designation for this species, and no critical habitat has been designated.

## B.2.18.1 Distribution

The current distribution of rose-mallow in California includes occurrences in Butte, Contra Costa, Colusa, Glenn, Sacramento, San Joaquin, Solano, Sutter, and Yolo Counties. Most of the approximately 119 known occurrences are in the Delta region. This species is also known in eastern North America (California Natural Diversity Database 2004).

## B.2.18.2 Life History and Habitat Requirements

Rose-mallow is a herbaceous perennial of the mallow family that grows to approximately 7 feet in height (Hill 1993). The large, showy, white flowers with deep-red centers generally bloom between June and September (California Native Plant Society 2001). Rose-mallow is an herbaceous perennial that spreads by rhizomes within tidal emergent wetland habitat.

## B.2.18.3 Endangerment

Most occurrences of rose-mallow are very small and are threatened by development, agriculture, recreation, and channelization of the Sacramento River and its tributaries (California Native Plant Society 2001).

## B.2.18.4 Occurrence in the Study Area

Rose-mallow is an herbaceous perennial that spreads by rhizomes within tidal emergent wetland habitat. Surveys conducted by boat in June–September of 2000 and 2001 located approximately 36 stands of rose-mallow in the study area, including sites along Middle River downstream of the proposed barrier near the confluence with Victoria and North Canals, on West Canal within the dredging area, and on Grant Line Canal and Fabian and Bell Canal more than 1 mile upstream of the proposed barrier site.

There are 129 CNDDB-recorded occurrences for rose-mallow throughout its range and 79 occurrences in the Delta region (California Natural Diversity Database 2004); some of the rose-mallow stands identified during the 2000–2001 surveys may not yet be included in the CNDDB records. As with other covered plant species in the study area, rose-mallow locations were not regularly dispersed around the area but were found in significant clusters that correlate with the presence of in-channel islands with unmanaged habitat (i.e., not leveed, farmed, riprapped, or along setback levees). Rose-mallow was observed to occur primarily on clay banks in the intertidal zone from the 0 tide level to mean high tide and to tolerate erosion until roots were exposed and it was washed away (Witzman pers. comm.).

## B.2.19 Delta Tule Pea

The Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*) is categorized as List 1B by the CNPS. There is no federal designation for this species, and no critical habitat has been designated.

### B.2.19.1 Distribution

Delta tule pea historically occurred throughout coastal and estuarine marshes in the Central Valley and the San Francisco Bay region. This species was most prevalent in the San Francisco Bay region (Isely 1993). Delta tule pea occurs in Alameda, Contra Costa, Napa, Sacramento, Santa Clara, San Joaquin, and Solano Counties. There are approximately 119 known occurrences of Delta tule pea on private property and public lands managed by city, county, state, and federal agencies (California Natural Diversity Database 2004). Most known populations are relatively small, ranging from a few plants to about 200 plants (California Natural Diversity Database 2004).

### B.2.19.2 Life History and Habitat Requirements

Delta tule pea is an herbaceous, climbing perennial of the legume family (Isely 1993). This species occurs in freshwater and brackish marshes from sea level to 13 feet (4 meters) above sea level and generally blooms from May to September (California Native Plant Society 2001).

### B.2.19.3 Endangerment

Delta tule pea is threatened by agriculture, water diversion, dredging, mosquito abatement practices, levee construction and maintenance, recreation, grazing, and fishing. Other potential threats to this species include flood and erosion control projects and wetland restoration projects (California Native Plant Society 2001, California Natural Diversity Database 2004).

### B.2.19.4 Occurrence in the Study Area

Delta tule pea is a perennial herb that occurs along tidal sloughs, riverbanks, and levees near the water's edge. Some populations are partially inundated at high tide (California Department of Water Resources 1994). Approximately 134 acres of tule and cattail tidal emergent wetland, which is suitable habitat for Delta tule pea, have been identified in the study area, and 22 acres are in the project construction area. This species was identified at one site on Middle River approximately 2 miles north of the proposed barrier site during the 2000–2001 special-status plant surveys of the study area. Delta tule pea was also previously reported in the study area in the ISDP (California Department of Water Resources and Bureau of Reclamation 1996). The previously reported occurrence was located in tidal emergent wetland on the south side of the in-channel island on Grant Line Canal upstream of the proposed barrier site. The closely related *Lathyrus jepsonii* var. *californicus* was observed in this area during the 2000–2001 surveys. The nearest CNDDB-recorded occurrence is located approximately 3 miles northeast of the project area on an in-channel island in Middle River (California Natural Diversity Database 2004). Habitat at this location is emergent marsh adjacent to tule marsh.

There are 123 CNDDB-recorded occurrences for Delta tule pea throughout its range, and 41 occurrences within the Delta region (California Natural Diversity Database 2004). The nearest CNDDB-recorded occurrence is located approximately 3 miles northeast of the project area on an in-channel island in Middle River (California Natural Diversity Database 2004). Habitat at this location is tidal emergent wetland adjacent to tule marsh.

## B.2.20 Mason's Lilaeopsis

Mason's lilaeopsis (*Lilaeopsis masonii*) is designated as a California rare species under the California Native Plant Protection Act and categorized as List 1B by the CNPS. There is no federal designation for this species, and no critical habitat has been designated.

### B.2.20.1 Distribution

The current distribution of Mason's lilaeopsis is from the margins of the Napa River in Napa County, east to the channels and sloughs of the Sacramento–San Joaquin River Delta (Delta) in Contra Costa, Solano, Sacramento, Yolo, and San Joaquin Counties (California Natural Diversity Database 2004). Some of the largest populations have been reported from uninhabited islands in Suisun Bay, where there is no levee revetment and little human disturbance (Fielder and

Golden 1990). Much of the known and potential habitat for Mason's lilaeopsis is privately owned, but several state and federal agencies have jurisdiction over the Delta waterways where the species occurs. Several sites are protected on lands owned by the DFG, including four sites in San Joaquin County at the CCF (California Natural Diversity Database 2004). Seven other sites are owned by public agencies, including the DPR, USFWS, and U.S. Department of Defense naval facilities (Morey pers. comm.).

## B.2.20.2 Life History and Habitat Requirements

Mason's lilaeopsis is a minute, turf-forming perennial plant of the carrot family. This species is semiaquatic and is usually found on saturated clay soils in areas of fresh to brackish water that are regularly inundated by waves and tidal action. Plants are tolerant of brackish water but grow more vigorously in freshwater. Its habitat is transient because of varying bank stability and water salinity. Entire plants have been observed floating in the sloughs, suggesting that vegetative reproduction may be an important factor in colonization. This species also spread by rhizomes, and it is likely that some populations comprise mostly clones from individuals that initially colonized the habitat. The flowering time for Mason's lilaeopsis is April–October. (California Department of Fish and Game 1992a; California Department of Water Resources 1994).

## B.2.20.3 Endangerment

Mason's lilaeopsis is threatened by habitat loss resulting from flood control projects, especially where revetment has been used; channel widening and dredging; levee construction and levee protection projects; bank erosion; recreational development and use of waterways; weed control activities (especially for water hyacinth); saltwater intrusion; and changes in water quality resulting from decreased flows in the Delta (California Natural Diversity Database 2004).

## B.2.20.4 Occurrence in the Study Area

Mason's lilaeopsis occurs in the lower reach of the Napa River and throughout the Delta. The project area is located at the southernmost extent of its range. Mason's lilaeopsis occurs at numerous locations on tidal mudflats in the project area.

Field surveys conducted in June–September of 2000 and 2001 identified approximately 175 occurrences of Mason's lilaeopsis in the study area. At these locations, Mason's lilaeopsis occurs on in-channel islands and in unmanaged habitat. Mason's lilaeopsis stands located near the project area include:

- approximately 20 stands almost 0.5 mile downstream of the Middle River barrier site,
- up to three stands within the Grant Line Canal barrier site and nine stands within 0.5 mile upstream of the site,
- one stand less than 0.25 mile upstream of the Old River barrier site and another approximately four stands immediately downstream of the site,
- approximately 17 stands along the West Canal within the proposed dredging area,
- approximately six stands at siphon extension locations on Victoria and North canals, and
- approximately four stands at the siphon extension at the confluence of Old River and Grant Line/Fabian and Bell Canals.

There are 148 CNDDB-recorded occurrences for Mason's lilaeopsis throughout its range and 116 occurrences in the Delta region (California Natural Diversity Database 2004). Some of the 175 stands mapped in the study area overlap with these occurrences, and some are previously unrecorded.

Mason's lilaeopsis populations generally occur at elevations varying from approximately 0.5 to 2 feet national geodetic vertical datum (NGVD) (California Department of Fish and Game 1995; California Department of Water Resources 2001). Locations of this species can vary from year to year due because of the transient nature of the mudflat habitat on which it grows. Both lack of siltation and accelerated erosion can remove habitat and individual plants. Mason's lilaeopsis successfully tolerates disturbance because it spreads vegetatively by rhizomes. No seedlings were observed during a survey of the entire range of Mason's lilaeopsis, although small tufts were seen floating in the Delta region, indicating that the lilaeopsis may colonize sites by this method (Golden and Fielder 1991).

## B.2.21 Delta Mudwort

Delta mudwort (*Limosella subulata*) is categorized as List 2 by the CNPS. There is no federal designation for this species, and no critical habitat has been designated.

### B.2.21.1 Distribution

Delta mudwort is found throughout Contra Costa, Sacramento, San Joaquin, and Solano Counties. This species is also known from occurrences in Oregon and on the Atlantic Coast, where it is threatened by loss of habitat (California Native Plant Society 2001). There are 32 known occurrences in California on private properties and public lands administered by the DFG and the California

Department of Parks and Recreation (DPR) (California Natural Diversity Database 2004).

### B.2.21.2 Life History and Habitat Requirements

Delta mudwort is a small perennial member of the figwort family that grows from stolons into tufted mats. This species occurs along disturbed shorelines and intertidal areas that are tidally influenced and where competition is limited. Delta mudwort produces small white flowers on single stalks and generally blooms from May to August (Wetherwax 1993; California Native Plant Society 2001).

### B.2.21.3 Endangerment

Delta mudwort is threatened by livestock trampling, recreational activities, competition from nonnative plants, erosion by wave action, rises in sea level, and degradation of water quality (California Natural Diversity Database 2004).

### B.2.21.4 Occurrence in the Study Area

Field surveys conducted in June–September of 2000 and 2001 identified approximately 40 occurrences of Delta mudwort associated with instream islands and unmanaged habitat in the study area. Delta mudwort was found along Middle River and Victoria and North Canals and at several sites within the West Canal dredging area. During previous surveys in support of the *Interim South Delta Project Environmental Impact Report*, Delta mudwort was also found on Grant Line Canal growing in association with Mason's lilaeopsis (California Department of Water Resources and Bureau of Reclamation 1996).

There are 42 CNDDB-recorded occurrences for Delta mudwort throughout its range, and all are within the Delta region (California Natural Diversity Database 2004). Some of the 40 stands mapped in the study area overlap with these occurrences, and some are previously unrecorded.

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